Correlates of Physical Activity Among Middle-aged and Older Adults with Hazardous Drinking Habits in Six Low- and Middle-Income Countries

Abstract (150/150)

We investigated physical activity (PA) correlates among middle-aged and older adults (aged ≥50 years) with hazardous drinking patterns in six low-and-middle-income countries (LMICs). Cross-sectional data were analyzed from the World Health Organization's Study on Global Ageing and Adult Health. Hazardous drinking was defined as consuming >7 (females) or >14 (males) standard drinks per week. Participants were dichotomized into low (i.e. not meeting 150 minutes of moderate PA / week) and moderate-to-high physically active groups. Associations between PA and a range of correlates were examined using multivariable logistic regressions. The prevalence of low PA in 1,835 hazardous drinkers (60.5±13.1 years; 87.9% males) was 16.2% (95%CI=13.9%-18.9%). Older age, living in an urban setting, being unemployed, depression, underweight, obesity, asthma, visual impairment, poor self-rated health and higher levels of disability were identified as significant PA correlates. The current data provide important guidance for future interventions to assist older hazardous drinkers to engage in regular PA.

Keywords: alcohol; physical activity; exercise

There have been some suggestions that light alcohol consumption has a protective effect on cardiovascular illness as well as mortality, including all-cause mortality (Mukamal et al., 2006; Thun et al., 1997). Alcohol may also facilitate relaxation through social interaction (Blow, Serras, & Barry, 2007). However, excess alcohol consumptions and alcohol use disorder are associated with a range of deleterious, negative consequences that clearly outweigh these beneficial effects (Connor, Haber, & Hall, 2016). Across the world, there is increasing concern about the rising level of alcohol consumption and associated health, well-being and societal burden among middle and older age adults (Blazer & Wu, 2009). Among adults aged ≥50 years, about 5% of men and 1.4% of women have a past-year alcohol use disorder (Thun et al., 1997; Wu & Blazer, 2014). In developed countries, there is also evidence that hazardous drinking habits have increased steadily among older adults (Hallgren, Högberg, & Andréasson, 2009). The threshold for risky or 'hazardous' consumption arising from regular alcohol use is set by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) as more than seven standard drinks per week for women, and more than 14 per week for men (Force, 2004). Because of its deleterious long-term effects, hazardous drinking is an important public health problem in adults aged ≥50 years (Caputo et al., 2012) as it is linked to more than 60 different chronic diseases (Connor et al., 2016). Older adults are at an even greater risk for somatic co-morbidities (Vancampfort, Koyanagi, Ward, et al., 2017), harmful drug interactions, injury, depression, memory problems, cognitive impairments, and sleep problems that can all be induced by regular hazardous alcohol consumption (Barry & Blow, 2016). Moreover, excessive drinking is related to an increased risk for suicide in this age group (Morin et al., 2013). Beyond health consequences, alcohol use inflicts significant social and economic losses on individuals and society at large (Room, Babor, & Rehm, 2005; Skog, 2006).

The treatment of hazardous drinking habits in adults aged ≥50 years is currently approached in the same way as for younger individuals. Treatment options include pharmacotherapy (naltrexone), brief cognitive behavioral and behavioral therapies based on conditioning, motivational enhancement therapy and 12-step facilitation (mutual peer support) (Connor et al., 2016). Despite treatment advancements, relapse remains high with as many as 80% of older adults relapsing following a period of abstinence (Satre, Mertens, Arean, & Weisner, 2004). Pharmacotherapy has unwanted side-effects and compliance is often low (Reid, Teesson, Sannibale, Matsuda, & Haber, 2005). Considering these issues, there is a high need for novel adjunctive interventions that may help in alcohol abstinence.

There is robust evidence that physical activity (PA) is good for the health and well-being of older adults in the general population (Nelson et al., 2007). Interest is increasing in older people with hazardous drinking patterns as well, particularly given that PA has demonstrated benefits for many of the untoward comorbidities in this group such as diabetes (A.-R. Abubakari et al., 2009), depression (F. B. Schuch, Vancampfort, Rosenbaum, et al., 2016) and cognitive decline (Stubbs, Chen, Chang, Sun, & Ku, 2017). Although the association between PA and alcohol consumption is complex, with several general population studies reporting a positive association between these variables (Dodge, Clarke, & Dwan, 2016), available evidence suggests that exercise interventions in people with alcohol use disorders can have important mental and physical health benefits. A recent meta-analysis (Hallgren, Vancampfort, Giesen, Lundin, & Stubbs, 2017) demonstrated that exercise does not reduce self-reported daily alcohol consumption (standard mean difference, SMD =-0.886, p=0.24). However, in terms of the change in average weekly consumption, a statistically significant difference was observed favoring exercise (SMD=−0.656, p=0.04). Of importance, exercise significantly reduces depressive symptoms (SMD=-0.867, p=0.006), and improves physical fitness (SMD=0.564, p=0.01).

Considering the beneficial mental and physical health effects associated with PA participation (Nelson et al., 2007), there is a need to investigate what factors influence PA participation in middle-aged and older adults who regularly drink above recommended levels in order to develop evidence-based treatment programs. To the best of our knowledge, studies on PA correlates in middle-aged and older adults with hazardous drinking habits are missing (Condello et al., 2017). In addition to the overall lack of information on factors influencing PA participation in middle-aged and older adults with hazardous drinking habits, very little is known about PA correlates in middle-aged and older adults in low- and middle-income countries (LMICs) in general. This is important as these countries are characterized by a suboptimal treatment of hazardous drinking habits (Patel et al., 2007), and often a lack of knowledge regarding the benefits of PA, particularly in older persons (Pengpid et al., 2015; Vancampfort, Stubbs, et al., 2017). In this study, we have adopted an ecological framework to better understand the multiple influences on physical activity among hazardous drinkers in LMICs. Our model is similar to that originally proposed by Sallis, Owen and Fisher (2008) to explain common barriers to exercise participation, but with some adjustments. Specifically, we have taken into account findings from a recent Danish study which used Social Cognitive theory to help explain obstacles to exercise participation among alcohol dependent inpatients (Sari et al, 2017). Ecological models are appropriate

here because they take into account the interacting levels of influence on physical activity. This is especially relevant in LMICs, where both individual factors (e.g. somatic health, psychological wellbeing), social context (e.g. wealth and living arrangements), and environmental factors (e.g. urban or rural setting) interact to affect the opportunities for physically active lifestyles. In addition to these variables, we were also interested to measure and better understand the influence of social cohesion on physical activity among our participants (Social Cognitive theory). A diagrammatic summary of our proposed framework is available as Supplementary material.

Identifying correlates of PA in middle-aged and older adults with hazardous drinking habits within an ecological framework can aid in the development of successful PA interventions in this population, by highlighting the potentially modifiable correlates that may bring about increases in PA (e.g. social environment, health variables), or identify characteristics of specific subgroups most in need of intervention (e.g. demographics). Special attention should be given to vulnerable subpopulations, including individuals with hazardous drinking habits, in whom the antecedents and consequences of PA participation may differ.

Thus, given the aforementioned gaps within the literature, we aimed to assess PA correlates among community-dwelling middle-aged and older adults meeting the NIAAA criteria for hazardous drinking in six LMICs.

Methods

The Survey

We analyzed data from the first wave of the Study on Global Ageing and Adult Health (SAGE) which is publically available through the WHO website (http://www.who.int/healthinfo/sage/en/). The survey was undertaken between 2007 and 2010 in China, Ghana, India, Mexico, Russia, and South Africa, which were all LMICs at the time of the survey according to the World Bank classification. Ghana was the only low-income country. This survey included data on 42,489 individuals aged ≥18 years. Details of the survey methodology have been published elsewhere (Kowal et al., 2012). Briefly, a multi-stage clustered sampling design was used to obtain nationally representative samples of the non-institutionalized general population. The original sample consisted of adults aged ≥18 years with oversampling of those aged ≥50 years. We only include people aged ≥50 years with hazardous drinking patterns. The amount of alcohol consumption per week was assessed by asking participants how many drinks of any 'standard' alcoholic beverages they had on each day of the past 7 days. A country-specific show card with pictures was shown to the respondent to illustrate what was meant by a standard drink, that is a drink with net alcohol content ranging between 8 and 13 g depending on the country. Furthermore, we also calculated the average consumption of alcoholic drinks per week based on information pertaining to the past 12 months on (a) how frequently (on how many days) on average the participant had at least one alcoholic drink, and (b) how many drinks they had on average on the days they drank. Based on these three questions, those who consumed >7 (females) or >14 (males) standard drinks per week were considered to be hazardous drinkers (Force, 2004).

Following a standard research protocol in all countries, trained interviewers conducted face-to-face interviews using a standardized questionnaire to collect information. Standard translation procedures for the questionnaires were undertaken to ensure comparability between countries. The survey response rate ranged from 51% (Mexico) to 93% (China). Sampling weights were calculated to adjust for the population structure as reported by the United Nations Statistical Division. Ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards. Written informed consent was obtained from all participants.

Physical Activity (PA)

Levels of PA were assessed with the Global Physical Activity Questionnaire (Bull, Maslin, & Armstrong, 2009). The total amount of moderate-to-vigorous PA in a typical week was calculated based on self-report. Those scoring ≥150 minutes of moderate-to-vigorous intensity PA were classified as meeting the recommended guidelines (coded=0), and those scoring <150 minutes (low PA) were classified as not meeting the recommended WHO guidelines (coded=1) (World Health Organization, 2010).

Sociodemographic Variables

These included age, sex, highest level of education achieved (completed secondary or less), wealth, marital status (married/cohabiting or else), employment status (engaged in paid work ≥2 days in last 7 days: Y/N), household size (1, 2, ≥3), and setting (urban or rural). A hierarchical ordered probit model was used to create an index of household asset ownership of durable goods, dwelling characteristics, and access to services (e.g., improved water, sanitation, cooking fuel). The country-wise wealth quintiles were generated from this index [15].

Health Behavior

These comprised fruit and vegetable intake [≥2 (fruits) and ≥3 (vegetables) servings/day (adequate)] (Joint FAO/WHO Expert Consultation, 2003), and smoking (never, quit, current) (Koyanagi et al., 2015).

Mental health

Anxiety was defined as having severe or extreme problems with worry or anxiety in the last 30 days (B. Stubbs et al., 2017; Vancampfort, Koyanagi, Hallgren, Probst, & Stubbs, 2017). Questions based on the World Mental Health Survey version of the Composite International Diagnostic Interview (Kessler & Ustun, 2004) were used for the endorsement of past 12-month DSM-IV depression (American Psychiatric Association, 2000). Details are provided in eTable 1 (Appendix). The presence of mild cognitive impairment (MCI) was assessed with three tests (immediate recall, verbal fluency, and delayed recall) adapted from the CERAD (Sosa et al., 2009). Respondents were classified as having MCI if their test score was <lowest 7^{th} percentile (approximately <-1.5SD) for their age and country in any of these tests (Garin et al., 2016). Those having severe or extreme problems with sleeping, such

as falling asleep, waking up frequently during the night or waking up too early in the morning, were considered to have sleep problems (Koyanagi & Stickley, 2015b).

Physical Health

A stadiometer (cm) and a routinely calibrated electronic weighting scale (kg) were used to measure height and weight respectively. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, and categorized as <18.5 (underweight), 18.5-24.9 (normal), 25.0-29.9 (overweight), ≥30 (obese) kg/m^2. Participants who had severe or extreme bodily aches or pains in the past 30 days were considered to have bodily pain (Koyanagi & Stickley, 2015a). Chronic back pain was defined as having had back pain every day during the last 30 days (B. Stubbs, A. Koyanagi, et al., 2016). Fall-related injuries in the past 12 months were assessed with questions on the presence of bodily injury and cause (Stewart Williams et al., 2015). The participant was considered to have hearing problems if the interviewer observed this condition. Visual impairment was defined as having extreme difficulty in seeing and recognizing a person that the participant knows across the road (Freeman et al., 2013). Diabetes and stroke were solely based on lifetime self-reported diagnosis. Blood pressure was measured three times with a one-minute interval with the use of a wrist blood pressure monitor. The mean value of the three assessments was used. Hypertension was defined as having at least one of: systolic blood pressure ≥140 mmHg; diastolic blood pressure ≥90 mmHg; or self-reported diagnosis. For angina, arthritis, asthma, and COPD, the participant was considered to have the condition in the presence of self-reported diagnosis and/or symptom-based diagnosis using algorithms. Specifically, the validated Rose questionnaire was used for angina (Rose, 1962), and other previously validated symptom-based algorithms were used for arthritis, asthma, and COPD (Arokiasamy et al., 2017; Moussavi et al., 2007).

Physical Performance

Gait speed was based on a 4-m timed walk and was measured by asking the participant to walk at a usual pace. A cane or other walking aids were allowed. The interviewer recorded the time to completion of the 4-m walk. Slow gait was defined as a gait speed of ≤1 m/sec (Abellan van Kan et al., 2009). Grip strength was measured twice for both hands with the use of the Smedley's hand dynamometer. If the participant had any surgery in the last three months or arthritis or pain in the hand/wrist/arm, grip

strength was not measured for that hand. Weak handgrip was defined as <30kg for men and <20 kg for women using the average value of the two handgrip measurements of the dominant hand (Cruz-Jentoft et al., 2010).

Health Status

Self-rated health was evaluated by the question 'In general, how would you rate your health today?' Those who answered 'bad' or 'very bad' were considered to have poor self-rated health. Disability was assessed by the use of the 12-item validated version of the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) which consists of 6 domains (cognition, mobility, self-care, getting along, life activities, participation) (Üstün, Kostanjsek, Chatterji, & Rehm, 2010). Item Response Theory analysis was used to create a scale ranging from 0 (no disability) to 100 (maximum disability) (Tyrovolas et al., 2015).

Social Cohesion

As in a previous SAGE publication (Zamora-Macorra et al., 2017), a social cohesion index was created based on 9 questions on the participant's involvement in community activities in the past 12 months (e.g., attended religious services, club, society, union etc) with answer options 'never (coded=1)', 'once or twice per year (coded=2)', 'once or twice per month (coded=3)', 'once or twice per week (coded=4)', and 'daily (coded=5)'. The answers to these questions were summed (range=9-45) with higher scores corresponding to higher levels of social cohesion (Cronbach's α=0.78). A four-category variable was created based on quartiles.

Statistical Analysis

The statistical analysis was done with Stata 14.1 (Stata Corp LP, College station, Texas). The sample weighting and the complex study design were taken into account in all analyses by the use of the svy command in Stata. The analysis was restricted to those aged ≥50 years meeting the NIAAA criteria for hazardous drinking. Chi-squared tests (categorical variables) and Student's t-tests (continuous variables) were used to test whether the difference in sample characteristics between those with and without low PA is statistically significant. Past literature was used as a guide for the selection of the correlates of PA (Vancampfort et al., 2015). Multivariable logistic regression was used to assess the

association between each correlate (exposure) and low PA (outcome) while adjusting for age, sex, and country. Country adjustment was done by including dummy variables for each country in the models. In order to assess whether sex and age modify the association between the correlates and low PA, we conducted interaction analysis by including a product term of the correlate in question and sex or age group (50-64 years or ≥65 years) in the models. All variables were included in the models as categorical variables with the exception of age and disability (continuous variables). The sample weighting and the complex study design were taken into account in all analyses by the Taylor's linearization method. Results from the regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $P<0.05$.

Results

The final sample consisted of 1,835 individuals with hazardous drinking patterns aged ≥50 years (China n=1,066; Ghana n=316; India n=86; Mexico n=49; Russia n=117; South Africa n=201). This corresponded to 5.4% of the total number of respondents (n= 34,129) aged ≥50 years. The corresponding figures for the individual countries were: China 10.2%; Ghana 7.9%; India 1.4%; Mexico 1.3%; Russia 3.0%; South Africa 5.3%. The mean (SD) age of the final sample was 60.5 (13.1) years and 87.9% were males. The prevalence of low PA was 16.2% (95%CI=13.9%-18.9%). Among the sociodemographic factors, in the unadjusted analysis, compared to those meeting the recommended PA levels, a significantly higher percentage of females, urban residents, as well as unemployed and non-married individuals was observed in those with low PA, while average age was also older (**Table 1**). In terms of other factors, those engaged in low PA had a higher prevalence of depression, asthma, and visual impairment, slow gait and poor self-rated health, while they also had higher levels of disability (P<0.05) (**Table 2**). Furthermore, those engaged in low PA also had higher prevalence of low and high BMI. In the multivariable analysis, the only sociodemographic correlates significantly associated with low PA were older age (OR per one year increase=1.04; 95%CI=1.02-1.06; p<0.001), living in an urban setting (OR=1.65; 95%CI=1.01-2.68; p<0.05), and unemployment (OR=3.17; 95%CI=2.16-4.66; p<0.001) (**Table 3**). The significant positive correlates of low PA in other domains based on adjusted estimates included depression (OR=3.91; 95%CI=1.19-12.88; p<0.05), underweight (OR=1.97; 95%CI=1.06-3.67; p<0.05) and obesity (OR=2.40; 95%CI=1.07-5.35; p<0.05) compared to normal weight, asthma (OR=2.82; 95%CI=1.48-5.36; p<0.01), visual impairment (OR=5.54; 95%CI=1.28-23.95; p<0.05), poor self-rated health (OR=1.91; 95%CI=1.24-2.97; p<0.01), and higher levels of disability (OR per unit increase=1.03; 95%CI=1.02-1.05; p<0.001) (**Table 4**). Results from the regression analyses based only on middle-income countries (i.e., Ghana excluded) were similar (data not shown). Interaction analysis showed that COPD was a significantly stronger correlate of low PA among individuals aged ≥65 years than in individuals aged 50-64 years [OR=2.13 (95%CI=1.04-4.40) vs. OR=0.63 (95%CI=0.27-1.47) (significant interaction p<0.05). In terms of effect modification by sex, depression [men OR=5.75 (95%CI=1.56-21.28); women OR=0.46 (95%CI=0.12-1.75)], underweight (vs. normal weight) [men OR=2.65 (95%CI=1.29-5.45); women OR=0.50 (95%CI=0.17-1.49)], and disability [men OR=1.04 (95%CI=1.02-1.06); women OR=0.99 (95%CI=0.98-1.02) were significantly

more strongly associated with low PA among men than women while the OR for bodily pain was significantly higher for women compared to men [OR=2.26 (95%CI=0.67) vs. OR=0.39 (0.15-1.03)].

Discussion

General Findings

To the best of our knowledge, the current study is the first to explore PA correlates in people aged 50 years or older with hazardous drinking habits. While substantial research has been devoted to understanding the alcohol consumption habits and correlates of younger adults, particularly in Western cultures (Hallgren et al., 2009), less work has focused on older adults, with a paucity in LMICs, despite clear evidence of increasing consumption trends in some countries (Connor & Hall, 2015) . In our LMIC sample, the prevalence of hazardous drinking ranged from 1.3% in Mexico to 10.2% in China. This between-country variability may be due to differences in sociocultural factors. The current findings support our proposed ecological framework for understanding barriers and facilitators of physical activity among hazardous drinkers in LMICs. We observed that a combination of factors operating at multiple levels of the proposed framework, were significantly related to physical activity participation at recommended levels.

The sociodemographic factors significantly associated with low PA among hazardous drinkers in the multivariate analysis were older age, living in an urban setting and being unemployed, while from a health perspective, depression, low and high BMI, asthma, visual impairment, poor self-rated health and higher levels of disability were significant correlates of low PA participation.

Being unemployed was a strong correlate for low PA among hazardous drinkers. It is known that risky drinking increases the likelihood of unemployment and decreases the chance of finding and maintaining work, while risky drinking is more prevalent among the unemployed (Henkel, 2011). A recent cross-sectional study involving workers from the USA and Sweden found that among the employed, occupational PA is associated with higher total PA and less sedentary time for both genders (Kwak, Berrigan, Van Domelen, Sjöström, & Hagströmer, 2016). Next to physically demanding labor, active transport to and from work might be an underlying reason for the higher PA levels in those being employed.

The observation that older age was associated with less PA is consistent with data from the general population (O'Donoghue et al., 2016; Trost, Owen, Bauman, Sallis, & Brown, 2002). Nonetheless, it is important that PA is promoted in older age given the multitude of health and wellbeing benefits in this population (Nelson et al., 2007).

The gender-specific differences, i.e. depression, being underweight and disability are more strongly associated with less PA in men and bodily pain in women warrants further exploration.

Our study also showed that in particular older people living in urban environments are less physically active. Differences between rural and urban settings might be related to the fact that an urban environment in most LMICs is not conducive to safe PA due to unsafe traffic, increased risk of crime and fear of crime (De Bourdeaudhuij et al., 2015), which are in turn linked to stress and depression (Smit et al., 2016), and which might consequently be risk factors for hazardous drinking patterns as well. Next to this, urban employment (e.g. service-based jobs) usually entails far less physical labor than rural employment (e.g., farming) in LMICs.

Next to this, we found significant associations between low PA levels and the presence of underweight, obesity, depression, asthma and visual impairments. In LMICs, low body weight may be an indicator of malnourishment or other serious health problems such as HIV, which could prevent participation in planned exercise or limit the amount of daily PA (Vancampfort et al., 2016). Conversely, obesity and overweight have consistently been linked to physical inactivity in both developed (Salmon, Bauman, Crawford, Timperio, & Owen, 2000) and developing countries (A. Abubakari & Bhopal, 2008), with recent research pointing to dopaminergic impairments in obesity as one possible explanation for physical inertia and sedentariness (Kravitz, O'Neal, & Friend, 2016; Ruegsegger & Booth, 2017). Promoting PA has an integral role in preventing and managing overweight and obesity and the associated complications such as diabetes and cardiovascular disease.

Previous research already clearly demonstrated the co-occurrence of hazardous drinking and depression in the general population (Grant et al., 2006). Depression has been associated before as well with not meeting the PA guidelines in general population research (F. Schuch et al., 2017; F. B. Schuch, Vancampfort, Richards, et al., 2016) and perhaps not surprising given that depression is characterized by lowered mood and lethargy. Anhedonia is characteristic of many mental disorders, including depression, and may impair the initiation of exercise behavior or the pleasure usually derived from physical activity. Nonetheless, there is evidence that structured PA can improve symptoms of depression in older age and engagement is particularly increased when interventions are delivered by qualified exercise professionals with a motivation component (Brendon Stubbs et al., 2016). Although anxiety was not linked to low levels of activity in the present survey, in depression, co-morbid generalized or social anxiety could inhibit participation in group physical activities.

The relationship between alcohol and asthma have yielded mixed results. Some studies have reported that alcohol has a beneficial effect on asthma; others report worsening of symptoms (Cuddy & Li, 2001). It has been suggested that additives in alcoholic drinks cause bronchoconstriction and that pure ethanol has a salutary effect on asthma (Cuddy & Li, 2001). The fear of inducing an episode of breathlessness inhibits many asthmatics from taking part in PA (Good, Jagroop, & Dogra, 2017). One review has demonstrated links between physical inactivity, obesity and asthma which are purportedly mediated by increased systemic inflammation (Ten Hacken, 2009).

All the abovementioned co-morbidities and associated poor self-rated health and higher levels of disability should therefore be considered as important barriers for being physically active in older people who drink at hazardous levels in LMICs. Stigma and discrimination associated with these co-morbidities and hazardous drinking, although not a focus of this study, may however further complicate PA participation.

Limitations and Implications for Practice and Future Research

The current data should be considered in the light of some limitations. First, the study is cross-sectional, therefore cause and effect cannot be deduced. Future prospective research is required to disentangle the directionality between the presence of hazardous drinking and PA behavior and the effect on potential mediators. Second, although hazardous drinking increases the risk of developing an alcohol use disorder, and may be considered 'problematic' in itself, we were not able to confirm whether or not the participants had an alcohol use disorder based on established diagnostic criteria. Therefore, future studies should include a more complete alcohol use disorder assessment and ideally use a clinical diagnosis. Also, given that stigma, religious beliefs, social norms and gender roles may contribute to the underreporting of alcohol use in LMICs (WHO Expert Committee on Problems Related to Alcohol Consumption, 2007), it is possible that we were unable to capture all individuals who engage in hazardous drinking in our study due to underreporting. Third, PA was measured with a self-report questionnaire, which is known to be less accurate than objective assessments (Soundy, Roskell, Stubbs, & Vancampfort, 2014; B. Stubbs, J. Firth, et al., 2016). It is well known that self-reported measures can overestimate PA levels (Ainsworth et al., 2006). Fourth, we were not able to explore differences in PA participation in hazardous drinkers living in urban versus rural settings in more detail. Future research could explore the role of specific environmental attributes relevant to PA on mental

health populations (including hazardous drinkers) in LMICs such as the availability and quality of sidewalks, pedestrian zones, bicycle facilities, and factors affecting intersection quality (e.g., crosswalks, pedestrian signals). Also, prospective studies and quasi-experimental evaluations of improvements in urban environments on the mental and physical health of people with alcohol problems in LMICs are urgently needed. Next to this, PA supportive environments should become a vital component of a mental and physical health policy. Design of PA stimulating urban environments has the potential to contribute nearly 90 min/week of PA, which is 60% of the 150 min/week recommended in PA guidelines (Sallis et al., 2016). In addition, future studies would benefit from assessing to what extent macro-level environmental factors such as food insecurity, civil conflicts, and extreme weather in LMICs are linked to physical inactivity in the older population in these countries. Finally, we acknowledge that 'hazardous drinking' is a terminology with slightly different meanings globally. Nonetheless, we adopted the widely used NIAAA definition (Force, 2004), which typically includes two dimensions; the average volume of alcohol consumed, and patterns of regular heavy drinking occasions. As the questionnaire used in the WHS did not include specific questions about the number of drinks consumed 'on a single occasion', we relied on the former criteria to identify hazardous drinkers; that is more than 7 (women) and 14 (men) drinks consumed per week during the past 12 months.

Despite these limitations, our data offer some evidence for cautious educational, community-based and clinical recommendations. First of all, a curriculum review for clinical and public health courses should be undertaken in LMICs to include PA in the management of hazardous drinking habits in older people. Well-tailored continuous medical education should be conducted in medical settings in LMICs, and can be used to equip medical professionals with the necessary knowledge to promote PA in older people with hazardous drinking habits. Second, our data demonstrate that assisting people with hazardous drinking in a job reuptake might be an important strategy to increase their PA levels, which in turn might improve their physical and mental health status. Third, from a clinical perspective, our current results suggest a need to consider the presence of depression, somatic co-morbidities and a poor self-perceived health status in people with hazardous drinking habits.

In conclusion, our data illustrate that a number of sociodemographic and health factors are associated with PA levels among middle-aged and older adults with hazardous drinking patterns in six LMICs. These findings provide guidance for future educational, population and clinical level

interventions across LMICs to help middle-aged and older adults with hazardous drinking to become more active.

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